Precision Measurement of the Reactor Antineutrino Spectrum with TAO

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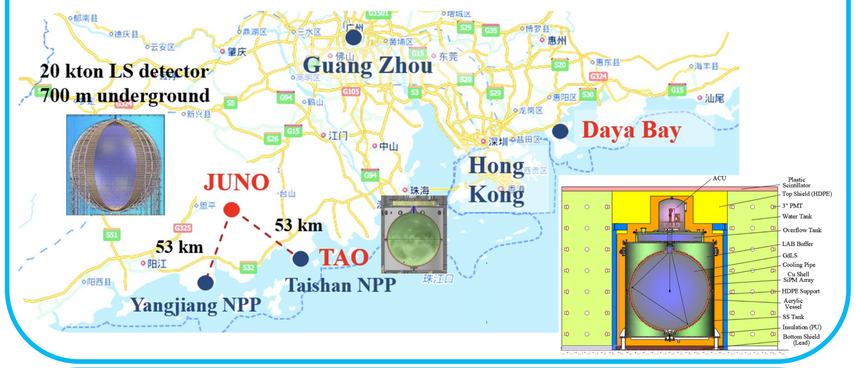
1. Introduction

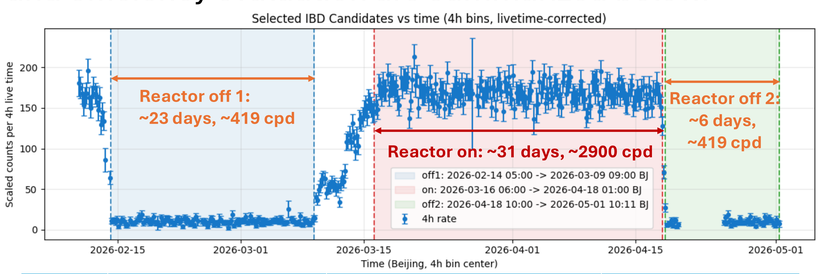
The Taishan Antineutrino Observatory (TAO) is a satellite experiment of JUNO. Located ~43 m from a reactor core of the Taishan Nuclear Power Plant (4.6 GW), ~9.6 m underground. TAO measures reactor antineutrinos via inverse beta decay (IBD) in a ton-scale liquid scintillator detector instrumented with SiPMs.

TAO performs precision measurements of reactor antineutrino energy spectra for JUNO and future reactor neutrino studies.



2. Dataset & Event Selection

This analysis uses TAO data collected from Feb. 10 to May 1, 2026, including ~31 days of reactor-on data and ~29 days of reactor-off data. The IBD candidate selection and efficiency evaluation are summarized below.

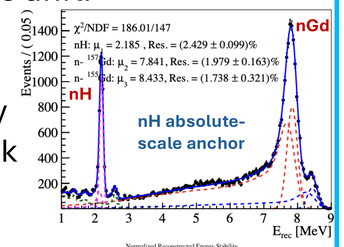


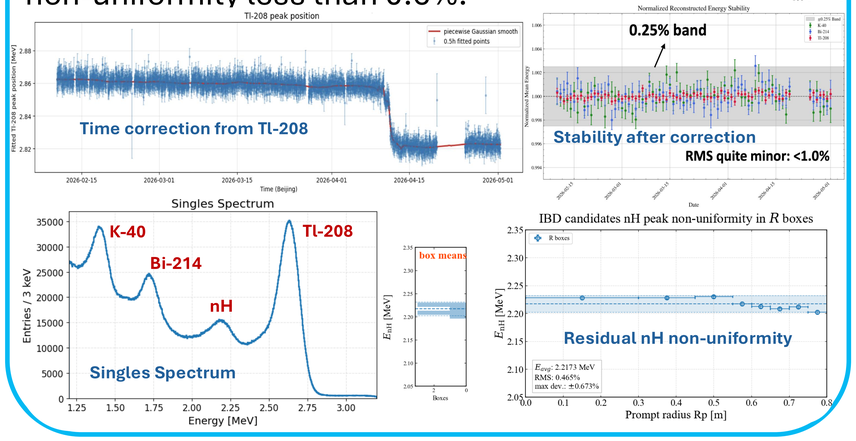
Category	Cut	Condition	Efficiency
Muon Veto	WT muon (≥18 PMTs/GCU)	[-2, 30] μs	For delayed signal: 95.1% For prompt signal: 97.4±0.01%
	TVT muon (≥ 3 layers fired)	[-2, 30] μs	
	CD muon (E > 20 MeV)	[0, 100] μs	
IBD Selection	Pre-selection	E in [0.7, 12] MeV, R < 875 mm	90±1.5%, 97.8±0.8%
	Pairing and Multiplicity	No other events in [T_p-100, T_d+100] us	96.0±0.01%
	Prompt–delayed time	[2, 100] μs	96.7±0.08%
	Delayed energy	[4, 10] MeV	74.6±4.0%
	Prompt–delayed distance	ΔR < 500 mm	96.4±2.6%
	Fiducial volume (prompt)	R < 800 mm	85.6±7.4%
Total	-	-	46.6±5.0%

3. Energy Calibration & Stability

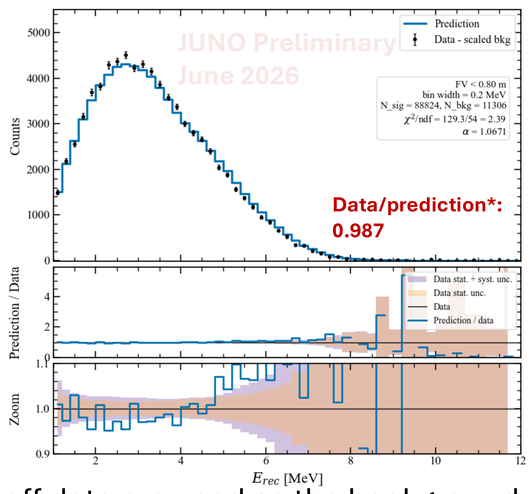
The reconstructed ^{208}Tl peak is used to correct the temperature-induced energy-scale drift.

After correction, reference peaks remain stable over the full data-taking period. The absolute energy scale is anchored with the nH peak at 2.223 MeV, with residual nH non-uniformity less than 0.6%.





4. Measured Prompt-Energy Spectrum

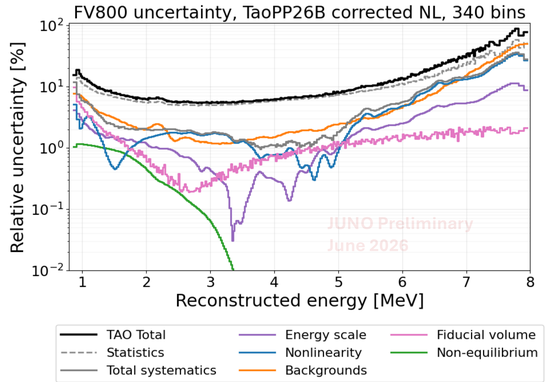


Reactor-off data are used as the background sample and subtracted from reactor-on data after livetime normalization. The measured spectrum and rate are consistent with the prediction within uncertainties.

* Prediction includes fission fractions, thermal power, baseline, IBD cross section, detector response, and selection efficiency.

5. Uncertainty

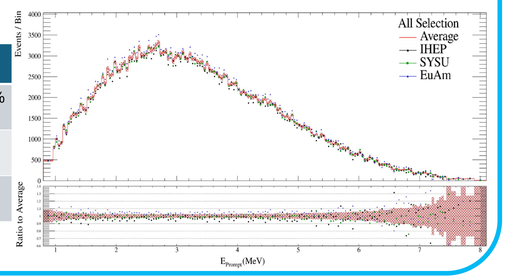
The uncertainty includes statistics, energy response, fiducial volume, backgrounds, and reactor non-equilibrium effects. All components are propagated to the 340-bin prompt-energy spectrum using covariance matrices.



6. Independent Analysis Cross-checks

Three independent analyses use different event-selection strategies to cross-check the spectrum measurement. The reconstructed spectra are consistent over the full prompt-energy range, and the IBD rates agree within uncertainties, supporting the robustness of the result.

	IHEP	EuAm	SYSU
Selection eff.	46.6±5.0%	44±6%	41.8±3.4%
Rate-on/day	2900±10	2860±10	2650±9
Rate-off/day	419±4	289±3	380±4



7. Summary

- The 2026 TAO reactor-on/off data provide a first measurement of the prompt-energy spectrum.
- Residual energy non-uniformity after calibration < 0.6%.
- The measured spectrum and rate are consistent with the prediction within uncertainties.